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# The Effects of Protective Eyewear on Tow Field of View



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DIVISION OF OCULAR HAZARDS RESEARCH



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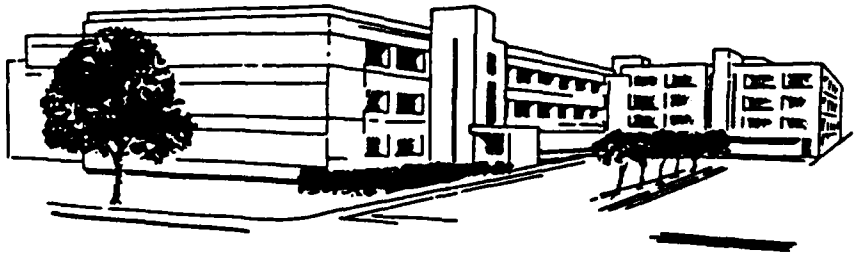

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Human Subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Reg 50-25 on the use of volunteers in research.

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The purpose of this experiment was to quantify the effect of wearing Ballistic and Laser Protective Spectacles (B-LPS) on an M-47 TOW (Tube-launched, Optically-tracked, Wire-guided missiles) gunner's field of view. The within-subjects design had three conditions: no eye wear, clear B-LPS only, and clear B-LPS with laser protective frontserts. Under each condition the observer's field of view was measured by bringing the reflection of a laser into the periphery from each of the four cardinal directions. As expected, the observer's field of view while wearing either configuration of the B-LPS was significantly smaller than the field of view while wearing no eye wear. This degradation could have a great impact on tracking performance, and is another factor to be considered in employing the B-LPS. (KR)

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# THE EFFECT OF PROTECTIVE EYEWEAR ON TOW FIELD OF VIEW

Bryan E. Campbell, George R. Mastroianni
and David A. Stamper

## INTRODUCTION

The proliferation of lasers in modern battlefield weapons has increased concern about the level of ocular protection currently available for soldiers. The risk of ocular injury by ballistic fragments has always been great, causing 10-15% of battlefield injuries by some accounts.[1] The apparent threat from battlefield laser weapons designed specifically to cause ocular injuries adds new urgency to the development of adequate combat ocular protection.

Fielding a combat ocular protection system is a difficult and complex process. Among the considerations involved are the effects that these devices can have on a soldier's ability to perform both everyday tasks and his warfighting mission. One mission involves locating, tracking, and engaging enemy vehicles using the TOW missile system. The TOW system uses high power optics to magnify and track the enemy target. One drawback of the B-LPS, resulting from a built-in feature to accomodate corrective lens inserts, is that they rest very far away from the face. This distance effectively moves the gunner's eye away from the designed focal point for the TOW and reduces his field of view (FOV).

Our hypothesis for this experiment was that while wearing the B-LPS the FOV would be significantly smaller than while wearing no protective eyewear. Furthermore, since the frontsert design adds another increment of distance between the gunner's eye and the TOW objective lens, the FOV with frontsert should be still smaller than that observed with B-LPS alone. That such a reduction will occur is intuitive given the optics of the device; however, we felt it profitable to quantify the amount of the effect and to determine whether the difference in FOV was likely to produce mission-relevant degradation.

## METHOD

Observers: Observers were 13 members of the staff at Letterman Army Institute of Research. There were 11 men and 2 women in this experiment, ranging in age from 19 to 45 years. Due to the magnifying properties of the TOW, corrective eyewear was neither needed nor worn.

Apparatus: The apparatus used in the experiment consisted of a 10mW Helium-Neon laser reflected off a white-paper scale on a wall 48 ft away. The scale was made from sheets of computer paper with markings every 5 cm. Observers viewed the laser on the scale by looking through the sight of a TOW missile system mounted at a comfortable sitting height. For the first experimental condition, observers viewed the scale using only the clear ballistic goggles. The second condition added a 2 mm green frontsert to the clear goggles. For the third condition observers wore no eyewear. The intensity of the laser was great enough that the tint of the frontsert did not affect the observer's ability to visualize the laser.

Procedure: For each of the conditions the observers were asked to look through the TOW sight and to center their FOV at 0,0 on the scale. They were instructed to remain fixated at 0,0 throughout the testing. The laser was moved from 0,0 toward the periphery until the observer stated that the reflection was no longer visible. The laser was then moved back toward the center until it was again visible. Each observer was measured twice in each cardinal direction for each of the three conditions. The order of presentation of the three conditions was counterbalanced in an exhaustive sequence.

## RESULTS

The FOV was calculated by summing the measurements in opposite cardinal directions. This sum and the known distance of 14.4 m (48 ft) were used to calculate the angle subtended, the FOV. A repeated measures ANOVA on the data from all three conditions yielded a significant main effect ($F(5,12) = 304.464$, $p < .001$) with the control group yielding a much greater mean FOV of 5.966 degrees. (See Table) This compares to a FOV

of 2.268 degrees for the clear B-LPS and a FOV of 1.995 degrees for the green frontserts. No interactions were significant. Although there was a difference in the mean FOVs between the two B-LPS conditions (B-LPS alone and B-LPS with frontsert), it was not significant at the .05 level.

**Table 1**

Mean FOV for Each Condition

| | Condition | | |
|---|---|---|---|
| | Control | Clear | Frontsert |
| Mean | 5.97 | 2.27 | 1.99 |
| SD | .65 | .60 | .45 |

## DISCUSSION

The results supported our hypothesis that the B-LPS would have a detrimental effect on a TOW gunner's FOV. More importantly, we were able to quantify the degree to which the B-LPS would reduce FOV. The loss was dramatic at 62%. This is a substantial effect and might indeed impair a gunner's ability to track targets. Moreover, this reduction will probably make it more difficult to locate a target while looking through the TOW sight.

Additionally, almost all the observers complained that the pressure of the B-LPS on their faces made them uncomfortable. Prolonged use under these conditions could become intolerable and result in a loss of concentration.

## CONCLUSION

Given the effect that the B-LPS have on FOV, tests should be conducted to find out how the loss in FOV affects a TOW gunner's performance in locating, tracking, or engaging enemy vehicles. The results of the present study would suggest that performance may also

be affected on other optically based weapons and equipment. Before the employment of these devices in the field, more research and perhaps a new design will be necessary if we hope to gain the maximum advantage from their use.

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